AMD DLl60 and DL320 Series Flash: New Densities, New Features

Technology Background

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The following document refers to Spansion memory products that are now offered by both Advanced Micro Devices and Fujitsu. Although the document is marked with the name of the company that originally developed the specification, these products will be offered to customers of both AMD and Fujitsu.

Continuity of Specifications

There is no change to this document as a result of offering the device as a Spansion product. Any changes that have been made are the result of normal documentation improvements and are noted in the document revision summary, where supported. Future routine revisions will occur when appropriate, and changes will be noted in a revision summary.

Continuity of Ordering Part Numbers

AMD and Fujitsu continue to support existing part numbers beginning with "Am" and "MBM". To order these products, please use only the Ordering Part Numbers listed in this document.

For More Information

Please contact your local AMD or Fujitsu sales office for additional information about Spansion memory solutions.

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TECHNOLOGY BACKGROUND

AMD DL160 and DL320 Series Flash: New Densities, New Features

AMD

Introduction

The DL160 series and DL320 series are the newest devices in the family of low power Simultaneous Read/Write Flash devices from AMD. These devices utilize the same revolutionary design techniques used in the Am29DL400 and Am29DL800 flash memories. These techniques enable the Flash device to perform two operations simultaneously (read while program or erase), allowing the system to achieve true background program/erase while executing directly out of the Flash device. Such capability allows system designers to combine the functionality of other memory components—such as EEPROM—into Flash, resulting in simpler, lower cost, and higher performance system implementations. In addition, the new high density devices introduce several new features. These include the new 64 KB SecSi™ (**Sec**ured **Si**licon) Sector, Sliding Bank Architecture, an accelerated program function, and hardware boot sector protection. In addition to these new hardware features, AMD now offers Data Management Software (DMS) to simplify user written software. The Am29DL family is ideal for a variety of embedded applications, especially applications requiring secure device identification such as cellular phones and set top boxes.

The design of the Am29DL flash family is based on AMD's industry-standard, 2.7 volt-only 0.32 µm Flash memory technology. The devices offer single-power-supply operation (2.7 V to 3.6 V), sector architecture, Embedded Algorithms, high performance, and a 1,000,000 program/erase cycle endurance guarantee. The devices also inherit the industry leading, low energy consumption characteristics of the Am29LV family, making it the ideal choice for system designers who need to minimize energy consumption in portable- and battery-powered applications.

The DL160 series and DL320 series devices offer the following:

- **True simultaneous operation that minimizes system overhead and improves system performance**
  - Device reads from one bank while programming/erasing another
  - No need to manage erase suspend and resume
- **Zero latency between program/erase and read**
  - The last program/erase command cycle can be followed immediately by read cycles
- **Dual-bank architecture with multiple bank size options**
- **64 KB SecSi Sector**
  - Extra space to store a secure Electronic Serial Number, permanently store code, or store data like any other flash sector.

- **Data Management Software**
  - Provides file management capabilities and simplifies user written system software
- **Faster Factory Programming with Accelerated Program Mode and Unlock Bypass Mode**
- **Low current consumption**
  - 200 nA typical standby current
  - 7 mA typical read current
- **High performance—access times as fast as 70 ns**

Table 1. DL160 and DL320 Series Device Bank Sizes

Device	Bank 1 (Mb)	Bank 2 (Mb)
Am29DL162	2	14
Am29DL163	4	12
Am29DL322	4	28
Am29DL323	8	24

Note: Additional bank splits may be available based on demand. Please contact an AMD representative for more information.

Simultaneous Read/Write Technology

AMD achieved significant design advances with Simultaneous Read/Write technology. From the system's perspective, Am29DL products behave as if there were two separate Flash devices inside the package operating independently. The system can program or erase one or more sectors in one bank while reading from the other bank with zero latency when switching between banks. Internally, the simultaneous operations are accomplished with minimal duplication of device functional blocks. Like other AMD Flash devices, there is only one high voltage circuit for program and erase, one state machine that manages device operations, one address decoder, one set of output drivers, and so on. Key functional blocks are shared so that the die size is minimized. This feature is important since AMD targets the Am29DL family at cost sensitive applications.

Externally, the Am29DL family's pinouts are identical to that of the industry standard Am29LV family. There is only one set of address bus, data bus, and control signals. Accordingly, only a single chip enable (CE#) is necessary to address and initiate operations in

either bank. Standard microprocessor write timings are used to set up program and erase operations. The upper bits of the address field specify the bank in which read, program or erase operation will take place. After appropriate commands have been sent for the program/ erase operation in the bank specified, the other bank is still available for read operations.

In a typical embedded application, the memory system may contain EEPROM for data storage and Flash for control code storage. With the Am29DL family, space can be structured to store data and boot code in bank 1 and control code in bank 2. The command sequence that tells bank 1 to program/erase data sectors resides as executable code in bank 2. While bank 1 is being programmed/erased, the system can continue to execute code from bank 2 to manage other system operation (depending on the system implementation, the CPU can also execute code from bank 1 and program/erase bank 2). There is no bank switching latency. There is no need to suspend program or erase operation. The CPU's read and write cycles can be maximized. The overall system cost is lowered because the EEPROM is eliminated. This is truly a Simultaneous Read/Write solution!

New High Density Device Features

SecSi Sector

The DL160 series and DL320 series memory products provide an extra 64 KB sector called the SecSi (**Sec**ured **Si**licon) Sector. The SecSi Sector is unique since it can be programmed and permanently locked prior to shipment by AMD, or by the customer. To guarantee that a **Customer Lockable** part cannot be used to clone a **Factory Locked** part, the SecSi Indicator Bit (DQ7) is permanently set to a "0" for Customer Lockable parts, and to a "1" for Factory Locked parts.

The **Factory Locked** version offers several options to customers. Factory locked parts can be shipped with a secure 16-byte Electronic Serial Number, with custom code programmed through AMD's ExpressFlash Service, or both. For applications that require device identification to prevent cloning, AMD programs the SecSi Sector with a secure 16-byte Electronic Serial Number. To prevent fraud, operating code should check that the SecSi Indicator Bit is programmed to a "1" (indicating a valid, Factory Locked device) then verify the ESN. This anti-cloning feature is ideal for devices such as cellular phones and set top boxes.

In applications susceptible to data corruption by external sources (such as computer viruses) the **Factory Locked** SecSi Sector can be used to store backup code. Since this sector can

never be changed, this code is completely safe from corruption. Systems can be designed to utilize this sector as a backup that calls for downloading of new system code when system code fails or is corrupted. Using the SecSi Sector this way ensures that corrupted system code will not require physical replacement of the flash. Finally, **Factory Locked** parts are available with a combination of both the ESN and ExpressFlash Service options.

Customer Lockable parts provide an altogether different set of options. Customers can utilize the space to initiate their own scheme of Electronic Serial Numbers, or install their own permanently locked code. Perhaps this option's greatest value is to utilize the extra 64 KB as bonus flash array space. Instead of buying a 16 Mb or 32 Mb part, customers actually realize a 16.5 Mb or 32.5 Mb part. This added space provides flexibility to support system code or data storage requirement that's grown just a little too big. Instead of migrating up to a higher density product, and wasting a lot of money and memory space, system designers can include the DL160 series and DL320 series in their existing product and delay density upgrades.

Sliding Bank Architecture

The DL160 series and DL320 series are designed with AMD's unique Sliding Bank Architecture. This architecture allows AMD to offer different bank sizes by applying different final metal masks. Sliding bank architecture allows customers to choose a part with the bank sizes that best fit their application. Initially, AMD will offer two devices in each density. Other bank options are available, and will be released given sufficient customer demand.

Storing code in one bank and data in another ensures that systems take full advantage of simultaneous operation. However, different applications will have different code and data size requirements. Thus, AMD offers multiple bank sizes. For example, cellular phones require more data storage space to accommodate the increased functionality of voice messaging, alphanumeric pages, and personal phone books. By offering similar products utilizing differently banked memory, OEMs may easily differentiate products by the amount of data they can store. (See Table 1 for device bank sizes.)

Write Protect Function

The Write Protect function provides hardware protection for two of the 8 KB boot sectors when the WP#/ACC pin is driven to V_{IL} (top 2 boot sectors in a top boot device, bottom 2 boot sectors in a bottom boot device). This extra hardware protection method ensures that critical boot code cannot be lost due to some software glitch. The two sectors can only be updated if the WP#/ACC pin is driven to V_{IH}.

Accelerate Function

To speed factory throughput, the DL160 series and DL320 series include an Accelerate function, also accessible through the WP#/ACC pin. Driving this pin to V_{HH} (8.5 V to 9.5 V) achieves a 56% increase in factory throughput.

Low Power Consumption

The Am29DL family operates with very low power consumption in both the active as well as the inactive states. The active modes (read, program, and erase operations) provide a significant reduction in power consumption versus competitive 3 volt offerings. A design technique called Address Transition Detection (ATD), saves power during program and read operations. ATD achieves power savings by analyzing the programming task and providing the optimal programming pulse (and thus the minimum power) required to complete the byte or word programming operation without sacrificing programming performance.

To minimize power consumption in the inactive states, the Am29DL family provides two power saving modes—Zero Power Operation Mode, and Standby Mode. Zero Power Operation automatically puts the device in sleep mode (I_{CC} = 200nA) whenever the device is inactive for more than t_{ACC} + 30ns. Standby Mode is a current-controlled method of entering sleep mode, requiring CE# and RESET# to be held at V_{CC}±0.3V. Both these modes require no latent period (or “wake up”) before they are ready to read. These techniques enable AMD to offer the most efficient flash memory chips on the market.

Standard Architecture

The Am29DL family is based on the same process technology and industry standard architecture as AMD’s 2.7 volt-only family of Flash devices. It offers the following standard features:

- ❏ JEDEC single-power-supply standard for pinout and software commands.
- ❏ Two memory arrays (banks) that are segmented into smaller sectors for erase operation. This feature allows for modular code development, storage of boot code, parameters, and main code in different sectors, and the ability to write protect any or all sectors of the device.

Reliability

The Am29DL family conforms to AMD’s stringent reliability requirements. AMD guarantees:

- A minimum endurance of 1,000,000 program/erase cycles. This equates to higher reliability in systems that rewrite data to the Flash device, even if they rewrite only once.
- 20 year data retention at 125° C, resulting in reliable operation for the life of the system.

Summary

The introduction of the DL160 series and DL320 series extend the Simultaneous Read/Write family and offer significant benefits to customers. They offer all the standard features and low energy consumption characteristics that are typical of AMD's 2.7 volt-only technology. Like all of the DL family, the new 16 Mb and 32 Mb products make it easy for designers to lower cost by displacing other memory devices like EEPROMs and SRAMs.

The new high density devices offer new features such as Accelerated Programming which speeds factory throughput by 56%. The new SecSi Sector protects against cloning and provides extra space for code storage. Beyond these features, the 16 Mb and 32 Mb devices were designed with Sliding Bank Architecture, allowing customers to choose the device that best fits their unique code and data storage requirements. These innovations continue to demonstrate AMD's leadership in NOR flash technology.

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